INDUSTRIALISED BUILDING SYSTEM VERSUS CONVENTIONAL SYSTEM IN WASTE PRODUCTION TOWARD SUSTAINABILITY IN CONSTRUCTION

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ABSTRACT

Industrialised Building System (IBS) is a system where buildings are reduced to a number of common parts, where most of it can be prefabricated in long term production runs, frequently away from the construction site. Lately, Malaysia government strongly support the usage of IBS in construction industry due to its quality assurance, shorter construction period, cleaner site condition, safer working environment and reduction in labour dependency. In this study, the advantage of IBS is focused on the reduction and management control of wastes, or basically minimizing wastes at the construction site which lead to sustainability in construction. Efforts to make IBS a success are not sufficient without the participation and support from the private sector. Questionnaire surveys were undertaken throughout the industry role players such as developer, consultant, contractor and government bodies. The analysis result showed that the involvement of the respondents in IBS was high and the awareness level was also considerably high. The use of steel in the conventional construction create the most waste and by using IBS the saving in material amount to approximately 54.83%. On the other hand, the set of timber does not show any significant material savings in either the conventional or IBS construction.

ABSTRAK

Sistem Binaan Berindustri (IBS - Industrialised Building System) merupakan sistem dimana struktur bangunan diringkaskan kepada beberapa bahagian ringkas dan mudah yang mana ia boleh direkabentuk dan diproses bagi pembuatan produk untuk jangkamasa yang panjang dan berterusan, jauh daripada tapak binaan. Kebelakangan ini, kerajaan Malaysia begitu menyokong penggunaan IBS dalam industri binaan terutamanya dari segi kawalan kualiti, jangkamasa binaan yang singkat, keadaan tapak yang bersih, persekitaran kerja yang selamat dan juga pengurangan dalam keperluan buruh. Dalam kajian ini, kebaikan pengunaan IBS dalam industri binaan difokuskan kepada pengurangan dan pengawalan sisa bahan binaan, pada amnya meminimumkan pembaziran di tapak bina yang akan menjurus kepada konsep pembinaan yang mapan. Usaha bagi menjayakan pengunaan IBS tidak akan terlaksana tanpa penglibatan dan sokongan daripada sektor swasta. Kajian secara soal selidik telah dilakukan dikalangan pihak yang terlibat dalam industri binaan seperti pemaju, perunding, kontraktor dan juga badan-badan kerajaan. Hasil analisis menujukkan bahawa penglibatan responden dalam penggunaan IBS adalah agak tinggi dan diutamakan. Walaubagaimanapun, tahap kesedaran tentang kebaikan dan keberkesanan IBS dalam industri binaan amat memberansangkan. Penggunaan besi dalam sistem binaan konvensional menghasilkan peratus sisa yang paling tinggi tetapi dengan adanya penggunaan IBS, pembaziran bahan binaan tersebut boleh dikurangkan sehingga lebih kurang 54.83%. Sebaliknya, penggunaan bahan berasakan kayu tidak menunjukkan penjimatan yang ketara dalam kedua-dua sistem konvensional dan IBS.

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LIST OF SYMBOLS

a	-	Constant
x	-	Variable
i	-	1,2,3….n
$\bar{x}$	-	Mean
x	-	Median
f	-	Frequency

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The Construction Industry plays an important role for growth of the Malaysia economy, which contribute about 2.9% of gross domestic product (GDP) in year 2010. However, it was one of the industries that contribute to high waste level in Malaysia. The conventional construction practices (basically cast in-situ where the entire structural components are cast on site) nowadays generated high level of waste.

Thus, the government has supported changes in the construction industry which bring development to the country. On 2007, the Prime Minister in his speeches at CIDB conventions stated that " Malaysia as a rising country which has most of the first world countries technologies, should not just bear the name of Advanced in Technology, but also has the mindset of the developed countries, which is to implement development. One of the ways that are quite reachable is through the construction industry which is Industrialized Building System (IBS), where it is the main attraction for construction player to have rapid, economic, safe, and free of wastage environment which lead to sustainable construction."

The demand of the building construction in Malaysia had increase rapidly from year to year together with the established of IBS as one of method of construction. This method is growing to lead more local manufactured established

themselves in the market. Industrialised Building System (IBS) is define as complete assembly construction system where components are manufactured at factories on or off site, transported and then assembled into a structure with minimum work. It is consider as better solution to reduce construction waste because it not only help reduce the total construction costs as well as faster the project completion, but it also has higher reduction of on-site labor, lower wastage, less site materials, and cleaner environment.

1.2 Problem Statement

Construction industry consume substantial amount of raw material in the process which generate product and also the construction waste material. In conventional system of construction, generally a total of 30% construction waste is generated and 60 – 80% of the waste can be reused and recycled. The waste such as timber, steel, plastic, concrete, and glass can actually be reused and recycled, but unfortunately they usually dumped and will lead to wastage of construction material which contributed to environment pollution.

1.3 Objectives of Study

i. To identify and compare the generated construction waste in different waste in different construction material between Industrialised Building System and conventional system.
ii. To study the awareness on sustainability in construction among the players in construction industry.
iii. To study the advantages of IBS in minimizing waste as an important criteria in sustainable construction.

1.4 Scope of Study

This study mainly focused on construction waste which becomes a problem towards the environment. To identify the efficiency of the IBS in minimized the generated construction waste, the comparison between the conventional method and IBS method were carried out. Data was collected mainly from the questionnaire survey which distributed to construction player such as client, consultant, contractor and construction workers who have experience in both type of construction method.

1.5 Significant of Study

This study was done to give awareness among the construction players on the advantages of using IBS method to improve on waste management, which is very an important criterion to a sustainable construction.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The objective of this research is to evaluate the performance of Industrialised Building System (IBS) in minimizing construction waste which is one of the aspects that has to be fulfilled to achieve the sustainable concept. The IBS is to be compared with conventional system in term of construction waste generated on site.

In this chapter, definition and description of sustainability, sustainable development and sustainable construction are given. IBS and conventional system of construction are described in detail and construction waste generated during the process of construction and demolition are also reviewed.

2.2 Sustainable Building

2.2.1 Definition of sustainability

Sustainability, according to Webster's American Heritage Dictionary, is to keep in existence; maintain. Sustainability which relates to our life means meeting our present needs without compromising the needs of the future generations. The sustainable approach recognizes the interaction of natural and technological systems

on our planet and seeks to minimize the adverse impacts in our everyday lives on the system that support all life.

The implication of the sustainability is to understand our local environment in terms of climate, natural resources and human resources to improve the relationship with these aspects without jeopardizing their future usefulness. Recognizing and understand the nature of the interdependence of human and natural environment is the key concept towards understanding sustainability. A sustainable approach encourages people to become a part of the natural flows and cycles of our world and not seeking to overpower them.

2.2.2 Sustainable development

The concept of sustainable development was first proposed by the World Commission on Environment and Development (WCED) which led by the Norwegian Prime Minister, Gro Harlem Brundtland in 1972 as "Meeting the needs of the present without compromising the ability of the future generations to meet their own needs". However, this definition has evolved since then.

During the United Nation Earth Summit held by the United Nations Environment Programmed (UNEP) in Rio de Janeiro (1992), sustainable development was defined as "Improving the quality of human life while living within the carrying capacity of supporting eco systems". This definition has an impact on the economic, social and environmental development and was later formally adopted worldwide. Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional changes are made consistent with future as well as present needs.

The word development in this definition implicates two major aspects of the concept: it is omnidisciplinary, it cannot be limited to a number of disciplines or areas, but it is applicable to the whole world and everything on it including human

being in present and future. The definition is based on two concepts which are the need concept and the limits concept. The need concept comprises of the conditions for maintaining an acceptable life standard for all human being while the limits concept is the limitation in the capacity of the environment to fulfill the needs of the present and the future, determined by the state of technology and social organization.

The needs consist firstly of basic needs such as food, clothing, housing and employment. Secondly, every individual in very part of the world should have the opportunity to try and raise their life standard above this absolute minimum. The limits consists of natural limitations such as finite resources which also includes of declining productivity caused by overexploitation of resources, declining quality of water and shrinking of biodiversity. For the best of the future, the needs should be fulfilled while the limits preferably decreased. If the needs and the limits are fulfilled, this would lead to the conclusion that all political, technical and social developments can easily be evaluated in the scope of sustainable development by these two arguments.

2.2.3 Environmental sustainability

The idea of environmental sustainability is to protect the Earth so that it will always be in the best condition for the future generations. By a definition, human activity is considered as environmental sustainable when it can be performed of maintained indefinitely without depleting natural resources or degrading the natural environment. These activities include:

- Minimum consumption of resources.
- Minimum production of waste (construction waste).
- Recycling of the waste streams would be 100%.
- Energy would be conserved and energy supplies would be entirely renewable and non-polluting.

- Materials consumed would be made entirely of 100% post-consumer recycled materials or from renewable resources (which do not harm the environment and without depletion of the resource base).

2.2.4 Sustainable construction

Sustainable construction was first defined by Kibert (1994) as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles". Sustainable designed buildings aim to lessen their impact on the environment through energy and resource efficiency. It includes the following principles: minimizing non-renewable resources consumption; enhancing the natural environment; eliminating or minimizing the use of toxins.

The inclusion of construction in sustainable development was proposed at the last World Summit for Sustainable Development held in Johannesburg in September 2002. Inspired of the various definitions, the aim and goals of sustainable construction remain the same. Sustainable construction is a way for the building industry to move towards achieving sustainable development, taking into account environment, socioeconomic and cultural issues.

The concept of sustainability in building and construction has initially focused on issues of limited resources, especially energy, and how to reduce impacts on natural environment with emphasis on technical issues such as materials, building components, construction technologies and energy related design concepts. One of the methods to reduce impacts on natural environment is to minimize both construction and deconstruction waste production. This can be achieved by the using IBS in construction besides the other method such as recycling or reusing of construction waste.

2.3 Industrialised Building System (IBS)

2.3.1 Definition of IBS

IBS stands for Industrialised Building System. There are few definitions of IBS according to few researchers. IBS can be defined as those incorporating a total integration of all subsystems and components into an overall process; one fully utilizing industrialized production, transportation and assembly techniques (Albert 1970). Further from there, IBS utilizes techniques, products, components or building systems which involved prefabricated components and on-site installation.

According to CIDB Malaysia, IBS may be defined as "construction systems in which components are manufactured in a factory, on or off site, positioned and assembled into a structure with minimal additional site works". It is a construction system that is built using pre-fabricated components. The manufacturing of the components is systematically done using machine, formworks and other form of mechanical equipment. The components are manufactured off-site and once completed will be delivered to the construction sites for assembly and erection.

Figure 2.1: Industrialised Building Systems (IBS)

It is interesting to note that the term "Industrialised Building Systems" (IBS) is often misinterpreted as systems limited only for the construction of buildings. In fact, IBS covers all types of structures as the word "building" actually relates to "constructing". (Shaari and Elias, March 2003).

2.3.2 Background of IBS

Industrialised construction system is not new to the building industry. The first panelized wood house in India was shipped from England in 1624 to provide temporary housing for fishing fleet.

Industrialised building systems have been used in construction industry in Malaysia for quite some time. Most of the systems which are marketed locally promise better quality, faster speed and more cost effective construction compared to the conventional approach of construction which local builders are so used to and quite reluctant to depart from. However past and recent experiences in the use of a few building systems in the country and abroad have suggested a need to carefully assess the systems that are being introduced in the country. This is necessary to ensure that the systems are suitable to the need of the Malaysia construction industry.

The use of IBS in Malaysia started back in 1963. In 1966 and 1967, the first two projects constructed using IBS method were the construction of 3009 unit of flats-accommodation in Jalan Pekeliling, Kuala Lumpur and 3741 units in Jalan Padang Tembak, Pulau Pinang. The success of IBS method in the country can be observed from the many structures built from the year 1995 to 1998. Such example is the Petronas Twin Tower, LRT and Kompleks Sukan dan Perkampungan Sukan Bukit Jalil. The IBS are also implemented in the construction of multiple-storey highway and monorail transit track that used pre-cast beam.

Though it has been four decades since the introduction of IBS in Malaysia, the application of this method in local construction industry is still low compared to developed countries such as Australia, United State, United Kingdom and Japan.

2.3.3 Characteristic of IBS

Systems to be accepted as part of IBS need to possess all characteristic below, as all of the five are equally important to ensure the achievement of the claimed benefits. The five characteristics of IBS are (Shaari and Elias, March 2003):

- Industrial production of components though prefabrication; or highly mechanized in-situ processes i.e. slip-forms, post- tensioning, tunnel shutters.
- Reduced labor during prefabrication of components and site works.
- Modern design and manufacturing methods i.e. involvement of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM).
- Systematic Quality Control i.e. ISO 9000 principles.
- Open Building Concept i.e. permitting hybrid applications, adaptable to standardization and Modular Coordination (MC).

2.3.4 Type of IBS

The Malaysian construction industry is undergoing a transitional change from an industry employing conventional technology to a more systematic and mechanized. In this system, IBS can be divided into five major types based on the structural aspects (Shaari and Elias, March 2003) as stated below;

- Precast Concrete Framing, Panel and Box Systems
- Steel Formwork Systems
- Steel Framing Systems
- Prefabricated Timber Framing Systems
- Blockwork Systems

2.3.5 Advantages of IBS

Advantages of IBS technology in the construction of commercial, residential and institutional building are well documented literature. It is commonly acknowledge that IBS technology has tremendous potential towards productivity improvement as it encompasses aspects of standardization, high controlled and quality IBS components which complements the various program to increase productivity and quality in construction industry.

2.3.5.1 High quality and aesthetical value of products

IBS products are manufactured in a casting area where critical factors including temperature, mix design and stripping time can be closely checked and controlled; and this will ensure that the quality of the products are better than cast-in-situ concrete. A huge sum of money will be saved by not having to do rectification works. Also due to factory-controlled prefabrication environment, many combinations of colours and textures can be applied easily to the architectural or structural pieces. A vast range of sizes and shapes of IBS components can be produced, providing a great deal of flexibility and offer fresher looks to the structures.

2.3.5.2 Cleaner and safer construction sites

Usage of IBS components eliminates or greatly reduces conventional formworks and props. IBS construction also lessens the problem of site wastages and the related environmental problems. The prefabricated products also provide a safe working platform for workers to work on. Workers and materials are also greatly reduced at the construction sites. Using Just-in-Time principles, the IBS components are kept at the factory yard until the site is ready for installation. Also, as elements

are produced in the plant and mostly designed to be repetitive, minimal wastage will be experienced at both factory and construction sites.

2.3.5.3 Faster construction

IBS construction will save valuable time and helps to reduce the risk of project delay and possible monetary losses. IBS design and production of components can be started while the construction site is under survey or earthworks. Production are also unaffected by weather conditions due to the controlled environment of the casting area. Also, the usage of large precast panels will reduce the time taken to complete the structural works. Therefore, other trades such as painting and electrical wiring can begin work sooner.

2.3.5.4 Greater unobstructed span

The usage of prestressed precast solutions such as the Hollow Core slabs and Double-T beams offer greater unobstructed span than the conventional reinforced concrete elements. Having lesser beams and columns, will provided larger open space. It is very ideal for the construction of places of worship, warehouses, halls, car parks, shops and offices.

2.3.5.5 Lower total construction costs

All of the above simplify the construction processes and increase productivity, quality and safety. As a result, the total costs of construction are reduced.